

Chapter 5. Monitoring

This chapter provides an overview of current species and habitat monitoring efforts in Wisconsin that are relevant to the Species of Greatest Conservation Need and identifies gaps in those efforts. The conceptual basis for monitoring Species of Greatest Conservation Need and their habitats is also presented, along with the basic approach for monitoring the effectiveness of the species and natural community priority conservation actions presented in Chapter 3. Strategies for adapting conservation actions through application of an adaptive management model are also described along with strategies for incorporating citizen-based monitoring into the monitoring efforts related to Wisconsin's *Strategy for Wildlife Species of Greatest Conservation Need: A Comprehensive Wildlife Conservation Plan*.

5.1 Overview and Purpose of Monitoring Species of Greatest Conservation Need, Natural Communities, and Priority Conservation Actions

The overall purpose of natural resource monitoring is to determine the status of and trend in the condition of selected resources. Information obtained from scientifically sound monitoring programs can be used to evaluate the effectiveness of management and restoration efforts, identify problems while cost-effective options are still available, provide early warning of threats, and provide a basis for understanding and identifying change in complex and variable natural systems. Monitoring data may help identify the normal limits of variation and can therefore also help determine when something may be wrong in a system (National Park Service's *Guidance for Designing an Integrated Monitoring Program at* <http://science.nature.nps.gov/im/monitor>). Knowing the condition of Wisconsin's natural resources is fundamental to the ability to manage those resources for the future.

This chapter seeks to provide a clear and holistic picture of monitoring in Wisconsin, through the identification of gaps at the taxa and ecosystem level, and through recommended actions that will result in greater coordination and higher quality data. The central goal is to use monitoring within an adaptive management context to test the effectiveness of conservation actions and to develop a long-term monitoring program for ecosystems, natural communities, and population trends of Species of Greatest Conservation Need.

Sections 5.2, 5.3, and 5.4 discuss monitoring as an element of the adaptive management cycle, data collection, and data sharing. Section 5.3 specifically focuses on assessing the effectiveness of conservation actions. Sections 5.5 and 5.6 consider all monitoring programs that involve Species of Greatest Conservation Need or their habitats in some way, even if they are only one component of larger monitoring activities. Sections 5.6 and 5.7 discuss multi-organizational monitoring initiatives and strategies.

While the following sections address Element 5 (see Chapter 1) as described by congressional legislation and further guidance from the National Advisory Acceptance Team, they do not suggest specific habitat and species monitoring priorities, protocols, or programs. There was insufficient time to develop specific monitoring programs for Species of Greatest Conservation Need, their associated natural communities, and priority conservation actions prior to the October 1, 2005 deadline for submitting Wisconsin's Comprehensive Wildlife Conservation Plan (CWCP). As a result, important first steps in the implementation of Wisconsin's CWCP will be working with partners to collectively recommend priority threats and conservation actions at a regional level and developing specific conservation action performance measures and monitoring strategies for those threats and actions.

5.2 Adaptive Management

Monitoring conservation actions and habitat trends is a critical step in wildlife conservation because it measures progress toward meeting an objective and provides evidence for continuation or change in the proposed management regime. As a component of the adaptive management cycle (Figure 5-1), monitoring ensures that each conservation action is linked to a specific hypothesis that evaluates the success or failure of the action, and, in turn, influences the adaptation of existing activities or the design of future actions.

Priority conservation actions and strategies proposed under the CWCP must be implemented by utilizing an experimental design that tests project assumptions and is part of an adaptive management cycle. Monitoring programs that use a formal experimental design not only determine if the expected results took place, but also suggest new conservation actions to implement or modifications needed to meet the originally intended outcome.

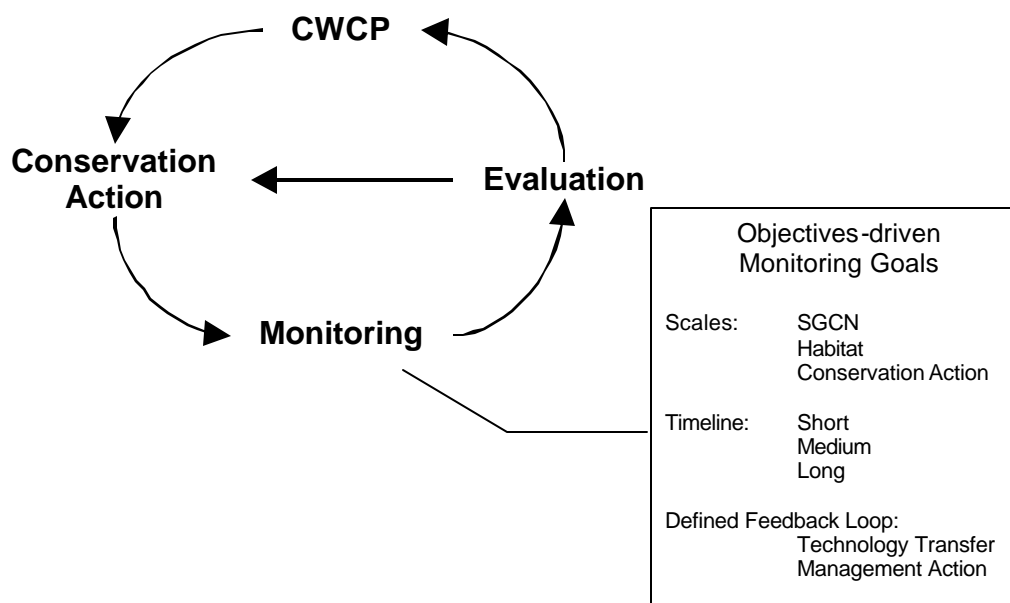


Figure 5-1. Monitoring within the adaptive management cycle.

Because monitoring may generate data that do not support the continuation of a proposed conservation action, the plan and conservation agency must establish guidelines governing the implementation of needed changes *before* an activity is undertaken in the field. Such guidelines will provide the ability to switch to another conservation action that may be more effective before the completion of the project, thereby conserving both ecological and fiscal resources. Consequently, all conservation action proposals should include an adaptive management component.

In order for monitoring to play a constructive role in the adaptive management cycle it must be tied to specific objectives. The project objectives describe the desired environmental outcome and in turn define what will be measured, how it will be measured, and how often it will be measured. Management activities are designed to meet the objective using an experimental design that tests its effectiveness, and monitoring is designed to determine if the objective is met or can be met under the proposed conservation

action. Regardless of the specific project objectives, the following actions ensure the completion of the adaptive management process:

1. Assess

- Define scope of management problem.
- Define measurable management objectives.
- Identify key indicators for each objective.
- Explore effects of alternative actions on indicators.
- Make explicit forecasts about responses of indicators to management actions.
- Identify and assess key gaps in understanding.

2. Design

- Design a management plan that will provide reliable feedback and fill gaps in understanding.
- Evaluate management options/alternative designs, and choose one to implement.
- Design monitoring protocol.
- Plan data management and analysis.
- State how management actions or objectives will be adjusted.
- Set up a system to communicate results and information.

3. Implement

- Follow the plan.
- Monitor implementation and document any deviations from the plan.

4. Monitor

- Monitor for implementation, effectiveness, validation, and surprises.
- Follow the monitoring protocol designed in Step 2.

5. Evaluate

- Compare actual outcomes to forecasts made in Step 1.
- Document results and communicate them to others facing similar management issues.

6. Adjust

- Identify uncertainties and where they remain unresolved.
- Adjust the model used to forecast outcomes, so that it reflects the hypothesis supported by results.
- Adjust management actions and reevaluate objectives as necessary.
- Make new predictions, design new management experiments, and test new options...repeat cycle.

The adaptive management cycle will be used to ensure that Wisconsin's *Strategy for Wildlife Species of Greatest Conservation Need* allows for evaluation of conservation actions and implementation of new actions accordingly. As mentioned in Section 5.1, there was insufficient time to develop specific monitoring programs for the CWCP, but as those monitoring programs are developed over the upcoming years and months, those programs will use the adaptive management philosophy outlined above.

5.3 Conservation Action Performance Measures

Because significant changes in populations and habitats often take many years to detect, progress toward the long term conservation strategy or goal must be monitored throughout the project period utilizing performance indicators. Ideally, monitoring plans track objectives for each performance indicator annually. Interim conclusions can then be drawn regarding the effects or outcomes at the site level that could influence implementation of similar conservation actions across the landscape or indicate the need for research on cause and effect.

Performance indicators are management tools that measure work performed and results achieved by stating inputs, outputs, and outcomes in specific and measurable terms. Table 5-1 below demonstrates the relationship between performance indicators, monitoring and adaptive management.

Table 5-1. The relationships among performance indicators, monitoring, and adaptive management.

	Input	Activity	Output	Outcome
Definition	Investments of staff/funding	Actions in the field	Products	Resulting environmental benefit
Example objective	Provide funding and staff time to develop a portable bat monitoring system to be used by volunteer monitors.	Contract for development of five bat monitoring sets built to staff specifications. Train volunteer monitors to calibrate and maintain systems, and collect data.	Five bat monitoring systems deployed and maintained in priority habitats, and data collected by volunteer monitors used to estimate bat population size and trends over time.	Appropriate conservation strategies applied for five high priority bat populations.
Example monitoring question	Were funds allotted to the development of portable bat monitoring systems and volunteer monitor training?	Were five functional systems built to staff specifications? Were volunteers trained to run the systems and collect data in a manner that will yield useable data?	Did the systems and volunteer monitors produce population and distribution data necessary to suggest appropriate protection measures for the targeted bat populations?	Were appropriate bat conservation measures proposed for five high priority bat populations?
Reporting mechanism	Conservation action proposal	Annual report	Annual and final report	Final report
Feedback loop examples	Conservation registry, similar conservation plans	Original proposal, similar conservation plans	Future conservation plans, proposed new research, NHI, ATRI	CWCP update, proposed new research, proposed new conservation actions

Successful implementation depends on clearly defined objectives, consistent monitoring, appropriate experimental design and good documentation over the life of the project. Consistently addressing the following questions through the appropriate reporting mechanisms ensures the completion of the adaptive management feedback loop:

- Are the assumptions of the original ecological model still valid? Should the model be modified based on collected data? Do the new data suggest another attribute would be more sensitive or easier to measure?
- Was the objective met? Although data from most monitoring may not conclusively identify causes of failure, what reasonable adjustment can be suggested? What additional research is needed? What was the agreed upon response outlined in the project proposal?

- Could the monitoring design be implemented as planned? What were the necessary modifications to methods, indicators, or timeline?
- Analysis after each data collection episode allows for the periodic assessment of the conservation action and the effectiveness of the monitoring approach. Are there quality assurance/quality control issues that need to be addressed?

Development of specific monitoring programs for Species of Greatest Conservation Need, their associated natural communities, and priority conservation actions will be important next steps in developing an implementation plan for Wisconsin's CWCP. The WDNR will work with partners to collectively recommend priority threats and conservation actions at a regional level. As part of that process, performance indicators, or metrics, will be developed for the priority threats and conservation actions to facilitate performance measurement.

5.4 Designing and Implementing a CWCP Monitoring Program

Information on the condition of Wisconsin's natural resources is fundamental to management of those resources. As described in Sections 5.5 and 5.6, many existing monitoring programs provide valuable information on our state's natural resources, and in many cases, this information is applied to land-use planning and management activities. This same information can be used, through the adaptive management process, to evaluate the effectiveness of new management or restoration efforts targeting Species of Greatest Conservation Need and their habitats. The following information should be considered before and during the design of new monitoring programs as well as during reviews of existing programs, recognizing that modifying existing programs may not be advisable if changes will negatively affect data continuity or comparability.

General principles and elements of a monitoring program (International Association of Fish and Wildlife Agencies 2005) include the following:

Principles

- Utilize existing monitoring efforts
- Integrate monitoring with local, regional, and national programs
- Produce quantitative, comprehensive assessments of the resource
- Strategically develop a short list of indicator species to monitor
- Relate habitat monitoring to species monitoring
- Maintain detailed, accurate documentation of data and results
- Strive for consistency of protocols among monitoring projects, so results are comparable
- Require internal and external peer-review of plans and products
- Encourage partnerships, leveraging of resources, and cost-sharing

Elements

- Identify monitoring goals and objectives
- Identify targets or indicators to monitor
- Determine sampling design and methodology
- Quality Assurance/Quality Control
- Data management and archiving
- Data analysis and assessment
- Protocol documentation
- Reporting
- Periodic review and evaluation

The development of a CWCP monitoring program in Wisconsin should include an analysis of the following initiatives and recommendations:

1. WISCLAND. Probably the most important first is to obtain a new land-cover GIS layer. The current "WISCLAND" is based on images from 1992-93 and significant changes in land-cover have occurred since that time. Current information is essential for the quantification of changes in land cover and for the spatial design of new monitoring programs.

2. An Inter-Agency Fish, Wildlife, and Habitat Surveys Team. Include continuing participation by relevant WDNR bureaus, state and federal agencies, conservation organizations, and the Citizen-Based Monitoring Advisory Board. Top priorities should be general awareness and coordination, and the development of a statewide monitoring plan (#3 below) to supplement the Wisconsin Comprehensive Wildlife Conservation Plan and any subsequent implementation plan. The Wisconsin Bird Conservation Initiative and the Wisconsin Old Growth Project may provide models of cross-jurisdictional organization. Team function should be established and staffing appointments made immediately following approval of the Wisconsin Comprehensive Wildlife Conservation Plan by the U.S. Fish and Wildlife Service.
3. A Statewide Environmental Resource Monitoring Plan. Based on the outcome and participation in the upcoming "Wisconsin Resource Monitoring and Data Sharing Network" workshop, an implementation plan (or series of plans) may be needed to address the monitoring needs of the Wisconsin Comprehensive Wildlife Conservation Plan. This plan should include, but may not be limited to, the following components.
 - Review the Wisconsin Comprehensive Wildlife Conservation Plan, any subsequent implementation plan, and past State Wildlife Grant projects. Consider the principles and elements from above (International Association of Fish and Wildlife Agencies 2005) and establish 6-month, 1, 2, 3, and 5-year benchmarks for the development and implementation of a statewide resource monitoring plan.
 - Identify focal management issues (e.g., the USGS Coordinated Bird Monitoring Plan <http://amap.wr.usgs.gov>) at the state, Ecological Landscape, and local scales.
 - Quantitatively evaluate relevant surveys. The Inventory and Monitoring Review (Wisconsin DNR 2004c) and this chapter cover *taxa* and *topical* limitations of existing surveys and monitoring programs. The ability of individual surveys and monitoring programs to meet *quantitative* objectives should be statistically tested and their limitations understood before these surveys can be adjusted or expanded to accommodate new interests. The Wisconsin Bird Conservation Initiative Research Inventory and Monitoring Committee will complete a bird survey evaluation in 2005.
 - Develop wildlife and habitat monitoring criteria and indicators (see the Montréal Process at <http://www.mpci.org> and the cautionary review of Sieg et al. 2003). Criteria and indicators should focus on the needs of the Comprehensive Wildlife Conservation Plan; however the information needs of WDNR programs and partner organizations should be considered, to the extent possible, to prevent the development of a segregated program.
 - Investigate the use of the "2010 Resource Monitoring Grid" (WDNR, Ecological Inventory and Monitoring Section, unpublished report), USDA Natural Resources Conservation Service "National Resources Inventory" sites (<http://www.nrcs.usda.gov/technical/land/nri02>), USDA Forest Service/WDNR "Forest Inventory and Analysis" sites (on public lands), and the proposed new WDNR "Continuous Forest Inventory" sites as the basis for a statewide biotic sampling framework. Incorporate State Natural Areas as potential control sites for habitat and taxa monitoring programs (Appendix C).
 - Utilize WDNR and relevant partner data standards (<http://atriweb.info/AboutATRI>); incorporate metadata into the Aquatic and Terrestrial Resources Inventory (<http://atriweb.info>) to increase project awareness and data sharing. Maintain Natural Heritage Inventory documentation and data management standards.

- Consider the following technical resources when developing the environmental resource monitoring plan:
 - USGS Coordinated Bird Monitoring Plan (<http://amap.wr.usgs.gov>) and the WBCI Coordinated Bird Monitoring Plan (in prep.).
 - U.S. Geological Survey “Managers’ Monitoring Manual: How to Design a Wildlife Monitoring Program” <http://www.pwrc.usgs.gov/monmanual>
 - U.S. Geological Survey “Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans” <http://www.dfg.ca.gov/nccp/pubs/monframewk10-04.pdf>.
 - National Park Service “Guidance for Designing an Integrated Monitoring Program” <http://science.nature.nps.gov/im/monitor/vsmTG.htm#Design>.
- Consider the following data management and archiving systems in the environmental resource monitoring plan:
 - Conservation Registry: Schoonmaker, P. and W. Luscombe’s (2005) *Habitat Monitoring: An Approach for Reporting Status and Trends for State Comprehensive Wildlife Conservation Strategies*, recommends the establishment of a state-level registry of conservation actions. The proposed registry is a spatially explicit database of conservation actions that would include conservation goals, location, habitat type, type of action, etc. This would allow agencies and partners to display the relationship between conservation action and stated priorities as well as identify geographic or habitat gaps in implementation of the plan. Data for a Wisconsin conservation registry can be compiled based on metadata submitted to the Aquatic and Terrestrial Resources Inventory (ATRI). Submittal of metadata is required by WDNR for all SWG funded projects in the state.
 - Citizen-based Monitoring GIS Layer: The Citizen-based Monitoring Network of Wisconsin will produce a GIS layer relating the kinds and geographic range of volunteer monitoring activities across the state. The tool will enable citizen-based monitoring groups to target monitoring gaps and access current monitoring data, protocols and monitoring guidance.
 - SWIMS: There are a variety of databases used by the WDNR to store water monitoring data, many of which are accessible to the public via the internet. However, these systems are not linked to one another and some are not easily accessible. To unify the various database systems and more easily access data from each of them, a project is underway to combine many of these databases as part of the new Surface Water Integrated Monitoring System (SWIMS), projected to be available by the end of 2006.
 - NHI: The Wisconsin Natural Heritage Inventory (NHI) program was established by the Wisconsin Legislature in 1985 and is part of an international network of NHI programs coordinated by NatureServe, a non-profit organization. These programs locate and document occurrences of rare species and natural communities (including state and federally endangered and threatened plants and animals) using a standard methodology for collecting, characterizing, and managing data. The programs maintain standardized databases with spatial and tabular components; the Wisconsin database contains over 21,000 records. In addition to its own inventory efforts, the Wisconsin program relies on data from contributors throughout the state. The Wisconsin NHI Working List contains the species and natural communities tracked by the program. Wisconsin NHI data are distributed at different levels of precision, depending on the user and the intended use of the data. Data with generalized locations can be obtained from the WDNR Web site by using either the “NHI Online

- Database” or “NHI County Maps.” A secure online application is used by WDNR staff and others that have a license agreement with NHI for obtaining more precise data.
- ATRI: The ATRI concept was formed in 1994 by DNR staff and external partners who recognized the need for decision makers to access and integrate environmental information. After considerable analysis concerning the role and structure of ATRI, the program was established by Wisconsin Statute 23.09(2)(km) which directed the Department of Natural Resources to “develop an information system to acquire, integrate and disseminate information concerning inventories and data on aquatic and terrestrial natural resources.” The Metadata Explorer is a computerized “card catalog” designed to help locate ecological data affecting Wisconsin's landscape. It is primarily composed of data collected by the WDNR, but also contains pertinent data from other sources.
4. Assist in the development of the Continuous Forest Inventory (CFI) on state lands. The Interagency Team and Comprehensive Wildlife Conservation Plan experts should provide direct assistance to the Division of Forestry in the development of the Wisconsin CFI which is proposed in the FY06-07 State Budget.

5.5 Species of Greatest Conservation Need Monitoring

Numerous agencies and organizations are involved in natural resource-related monitoring programs in Wisconsin. In 2004, the WDNR conducted a review of most bird, herptile, mammal, invertebrate, and plant inventory and monitoring programs to assess the adequacy of current efforts in meeting our collective information and data needs (Wisconsin DNR 2004c). The review covered key topics including population trend, distribution and range, habitat requirements, habitat condition and availability, population status, and wildlife health. A listing and description of those existing or historic inventory and monitoring programs that include Species of Greatest Conservation Need can be found in Appendix D. Because of the large number of species under consideration in the CWCP, we were forced to group species by status (endangered, threatened, and special concern), life history traits (e.g., colonial nesters), or coarse taxonomic groups for summary and discussion purposes.

The Wisconsin CWCP lists 152 mammal, bird, herptile, and fish species that need conservation actions in order to sustain or reestablish their populations (i.e., Species of Greatest Conservation Need, Table 3-1). Another 208 species have specific information needs because of unknown population trends or other life history traits (Appendix B); this number is in the tens of thousands when invertebrates are considered. Comprehensive inventory and monitoring strategies will be needed to measure the success of conservation actions for Species of Greatest Conservation Need, to reassess the status of Species of Greatest Conservation Need in the future, and to ascertain the status of the 208 species with information needs. This will require a major commitment from resource agencies and organizations in Wisconsin.

Most vertebrate species are monitored using cost-effective techniques that gather data on a variety of animals at once, such as track surveys for furbearers, point counts for passerine birds, trapping for small mammals, and fyke netting or shocking for large fishes. This leaves substantial gaps in species representation and information; usually only the more common species are encountered in sufficient numbers to provide accurate and precise estimates of population characteristics. Using these common or well-surveyed species as indicators for demographic trends in poorly known species has little scientific support (Sieg et al. 2003) and any such proposal should be carefully considered prior to acceptance as a “criteria or indicator” for monitoring.

5.5.1 Birds

Table 3-1 in Chapter 3 provides a complete list of bird Species of Greatest Conservation Need; this list also notes the species for which we need more data regarding state abundance, threats, population trend, or global threats. Numerous agencies and organizations collect bird monitoring data in Wisconsin (Appendix D, Table 1). Most surveys gather some information on Species of Greatest Conservation Need. Despite this, we are lacking data on many topics needed to fully assess status and to derive workable management strategies. Existing programs will need to be adjusted or expanded and new surveys will need to be implemented in order to address the significant weaknesses noted in the Inventory and Monitoring Review (Wisconsin DNR 2004c).

Gaps in Bird Monitoring

There are 284 native bird species for which Wisconsin provides important breeding, wintering, or migratory habitat. Of these 284 species, 84 (30%) have been identified as Species of Greatest Conservation Need in Wisconsin. Twenty-four of these are currently listed as Threatened or Endangered in Wisconsin and two are listed as federally Threatened or Endangered. Because of these large numbers, it was not feasible during the Inventory and Monitoring Review (Wisconsin DNR 2004c) to discuss the adequacy of existing monitoring programs and information for each species. Consequently we grouped species by status (endangered, threatened, and special concern), life history traits (colonial nesters), and

coarse taxonomic groups (waterfowl, passerines, etc.) in order to provide an overview of the perceived adequacy of monitoring information for these groups.

Endangered, Threatened, and Special Concern Species

In general, inventory and monitoring efforts are inadequate to address population trends, specific habitat requirements, habitat conditions and availability, population status, and wildlife health for most Special Concern species in Wisconsin. For certain listed species, good information is available. For example, there is good population trend data for nesting bald eagles, peregrine falcons, trumpeter swans, and whooping cranes. For many other listed species trend data is not readily available. Information on species distribution/range is better due to the recent breeding bird atlas (Wisconsin Society for Ornithology 2005). Current efforts will need to increase significantly in order to improve information and management opportunities. Specific needs include constant monitoring of grassland, forest, and wetland species.

Waterfowl

In general, monitoring efforts are adequate to address population trends and distribution/range for waterfowl and existing programs should continue at the current level. Specific needs include better population status information for ducks listed as Species of Greatest Conservation Need.

Colonial Nesters

Population trend and wildlife health monitoring efforts are largely inadequate for this group, while distribution/range and habitat requirement information was considered adequate. Our knowledge of habitat condition/availability and population status is variable by species within this group. Current efforts will need to increase in order to address population trends and habitat condition/availability, but information and data quality vary widely for the other topic areas due to the heterogeneity within this group. Specific needs include long-term monitoring and use of the Wisconsin Waterbird Registry or eBird (<http://www.ebird.org/content/>) to aid in data collection and synthesis.

Bitterns and Rails

Inventory and monitoring efforts are inadequate in all topic areas except habitat requirements where slightly more information exists. Efforts will need to greatly increase in all topic areas for bitterns and rails.

Shorebirds

Population trend, distribution/range, habitat condition/availability, population status, and wildlife health information and survey efforts are lacking. In general, habitat requirements for shorebirds are fairly well known. Specific needs include participation in regional long-term monitoring efforts and monitoring the effectiveness of management activities (e.g., draw-downs at managed impoundments).

Gallinaceous Birds

Because of long-standing efforts by the WDNR and other organizations, current inventory and monitoring efforts and information are largely adequate in all topic areas except wildlife health. Monitoring of habitat condition/availability and wildlife health should increase. Specific needs include more work in all topic areas for spruce grouse and sharp-tailed grouse.

Birds of Prey

In general, efforts to address population status are inadequate. The level or quality of information in all other topic areas is highly variable depending on the species in question. Specific needs, relative to Species of Greatest Conservation Need, include better information on all owl species, northern goshawk, red-shouldered hawk, and northern harrier.

Non-passerine Landbirds

Monitoring of population trends, habitat requirements, habitat conditions/availability, population status, and wildlife health are largely inadequate for this group. Efforts on all topics, except distribution/range, should increase. Specific needs for this group were wide ranging due to the diverse species composition.

Passerine Landbirds

In general, efforts to address population trends, habitat requirements, habitat condition/availability, population status, and wildlife health are inadequate and efforts must increase in order to gain needed management information. Information on species distributions/range are largely adequate. This is a large group, thus specific needs are wide ranging, but one significant deficit is a lack of programs to monitor and evaluate management projects.

Addressing Gaps in Bird Monitoring

Because of the large number of relevant bird surveys and the extensive species list involved, we do not attempt to provide specific recommendations for improving or expanding avian monitoring programs in this report. The Wisconsin Bird Conservation Initiative, a consortium of resource agencies, organizations, and supporting businesses, has a Research, Inventory and Monitoring Committee which is actively working on an evaluation of avian surveys and a coordinated bird monitoring plan for Wisconsin. This evaluation will scrutinize applicable surveys (Appendix D, Table 1) for species coverage, objectives, relevant spatial scales, types of data collected, and statistical adequacy. The "Evaluation of Avian Surveys" report will be released late in 2005 and a "Coordinated Bird Monitoring Plan" will follow in 2006.

5.5.2 Fish

Fish monitoring programs have been in place since the 1940s, with most monitoring activities focusing on recreationally or commercially important species. Current surveys range from tracking stocking and recreational fishing efforts to investigating habitat-species interactions, the impacts of development, and the effectiveness of management actions (Appendix D, Table 2). Fish Species of Greatest Conservation Need are rarely the focus of individual projects; however, in the majority of current monitoring programs, information on these taxa is often recorded when captured. Table 3-1 in Chapter 3 provides a complete list of fish Species of Greatest Conservation Need. This list also notes the species for which we need more data regarding state abundance, threats, population trend, or global threats. New or expanded monitoring efforts will be needed to obtain these data.

Addressing Gaps in Fish Monitoring

A comprehensive monitoring program is in place for Wisconsin's fisheries resources. Additional funding for fish tissue contaminant analysis would allow for expanded coverage and more detailed sampling (Wisconsin DNR 2005). Fish are currently collected from 50-100 sites per year. This includes analysis of approximately 600 samples for mercury, 350 for total polychlorinated biphenyls, 30 for banned pesticides, 20 for dioxin/furan analysis, and 10 for polybrominated diphenyl ethers. Monitoring temporal changes in contaminants at fixed sites is a priority not currently addressed in the fish contaminant program.

5.5.3 Herptiles

Compared to most other taxa groups, there are relatively few ongoing inventory and monitoring programs for herptiles in Wisconsin. Much of our knowledge of this group comes from a few ongoing efforts including the Wisconsin Frog and Toad Survey (WFTS) and the Natural Heritage Inventory, both programs of the WDNR, and the Wisconsin Herpetological Atlas Project, a program of the Milwaukee

Public Museum. Each of these programs provides information about the distribution of herptile species in the state, and the WFTS also adds data about breeding phenology and population trends. In addition to these state initiatives, several federal agency programs address amphibians and reptiles in Wisconsin, including the North American Amphibian Monitoring Program (NAAMP) and the Amphibian Research and Monitoring Initiative (ARMI), both of which are sponsored by the U.S. Geological Survey. Some of the federal programs complement state efforts, while others serve more to assist states with data and information management, analysis or interpretation. Other information regarding herptiles in the state is obtained through short-term research projects, which are usually focused on individual species or a small group of species, and through incidental observations by both citizens and scientists.

While past and current efforts provide information on some herptiles identified as Species of Greatest Conservation Need, many gaps remain. Table 3-1 in Chapter 3 provides a complete list of herptile Species of Greatest Conservation Need. This list also notes the species for which we need more data regarding state abundance, threats, population trend, or global threats. Existing programs should be expanded and new programs must be designed carefully to most effectively address remaining information needs.

Gaps in Herptile Monitoring

The information summarized below has been compiled from the following three sources, which should be referenced for more detailed information:

1. *WDNR's Inventory and Monitoring Review* (Wisconsin DNR 2004c)
2. *A review of the amphibians and reptiles of the Lake Superior Watershed* (Casper 2002)
3. *Monitoring long-term trends in Wisconsin frog and toad populations* (Mossman et al. 1998)

Reptiles

In general, current inventory and monitoring efforts for reptiles are not adequate to provide good information on status and trends or for directing management and conservation actions. Information is generally lacking for most species in the areas of distribution and range, habitat requirements, habitat conditions and availability, wildlife health and toxicology, and other stressors like climate change. However, fairly good information is available on habitat requirements for most turtles and on distribution and range of most snake species.

Amphibians

The Wisconsin Frog and Toad Survey (WFTS), initiated in 1981, is the longest running calling-frog survey in the United States and has been a model for other amphibian calling survey programs throughout the country. The primary purpose of the WFTS is to determine the status, distribution, and long-term population trends of Wisconsin's twelve frog and toad species (Mossman et al. 1998). The survey also provides information regarding the effects of climate and site factors on breeding-call phenology and breeding activity, which is useful in interpreting trend estimates (Mossman et al. 1998). While the WFTS provides an indication of general population trends for most Wisconsin anuran species, it does not adequately sample for some Species of Greatest Conservation Need such as pickerel frogs, mink frogs, and Blanchard's cricket frogs. In addition, the survey's geographic coverage currently falls short of the goal of two survey routes per county.

Individual monitoring programs are warranted for Blanchard's cricket frog and pickerel frog. Mossman et al. (1998) provides some suggestions for obtaining adequate monitoring information for these species. Additional information for most anurans is also needed in the areas of habitat requirements and condition, and health, including disease and contaminant exposure and effects.

For salamanders, current inventory and monitoring efforts are generally not adequate to provide good information on status and trends or for directing management and conservation actions. Efforts are lacking for most salamander species in the areas of distribution and range, habitat requirements, habitat conditions and availability, wildlife health and toxicology, and other stressors like climate change.

Addressing Gaps in Herptile Monitoring

A comprehensive plan for achieving monitoring goals is not currently in place for herptiles. Existing survey, inventory, and monitoring programs that include Species of Greatest Conservation Need are identified in Appendix D, Table 3. Funding to support herptile monitoring is generally low, although following WDNR's Inventory and Monitoring Review in 2004 (Wisconsin DNR 2004c), the Department has started at least two new efforts to address existing gaps (Blanchard's cricket frog and Butler's gartersnake surveys). More efforts are needed and should be coordinated across state and federal agencies and organizations. Coordination is also needed among survey and inventory work, monitoring efforts, and research. Survey, inventory, and monitoring efforts should be used to inform and direct more targeted research. Research information should then be incorporated into conservation actions and on-the-ground management activities. All of these areas in combination will help to create a more complete effort to address gaps in our knowledge of the herptiles of Wisconsin.

Efforts at addressing gaps in herptile needs throughout the state provide an excellent opportunity for collaborative participation by a wide range of groups. The WDNR is not the only agency with the ability to conduct inventory and monitoring efforts for reptiles and amphibians. There are opportunities to involve a variety of other groups in inventory and monitoring activities, including federal agencies, conservation organizations, citizen scientists, K-12 schools, and universities. Different groups are likely to be better suited to certain activities and topics than others. Citizen scientists could help provide data on the distributions and habitats of some species that are relatively common and easily identified if provided with appropriate resources (e.g., photos, user-friendly taxonomic keys). Other species are more difficult to inventory and monitor or may require more resources than are generally available to the public. Efforts in these areas will need to be undertaken by an appropriate agency or organization. Regardless of the specific type of work or who accomplishes it, a thoughtful, coordinated planning effort and a strong commitment by WDNR are important precursors to undertaking these efforts. A monitoring program for herptiles should be considered in conjunction with other monitoring needs for the state and should be an integrated part of a comprehensive, resource-monitoring program in Wisconsin.

The following specific suggestions for addressing information gaps for herptiles were compiled from the three sources listed in the previous section. Additional recommendations and conservation actions for individual herptile Species of Greatest Conservation Need can be found in Section 3.1.4.

- Implement more routes and surveys for all amphibian and reptile monitoring programs in the state.
- Use the existing network of WFTS sites for more intensive studies on population dynamics, microhabitat requirements, contaminants, and other areas of need.
- Initiate or increase participation in some of the existing nation-wide herptile monitoring programs (e.g., Terrestrial Salamander Monitoring Program, Frogwatch USA).
- Identify reasons for population changes.
- Where malformations are documented at a specific site in multiple years, conduct thorough water quality testing.
- Identify appropriate conservation and management practices for amphibians and reptiles in the region.

- Develop new volunteer programs for monitoring certain herptile groups including salamanders and turtles.
- Encourage the development and use of standard or comparable protocols, analytical tools, training and planning, and common databases and reporting mechanisms across ecological regions, scientific disciplines, and governmental and institutional boundaries.
- Compile existing information on all of Wisconsin's amphibian and reptile species and develop a database of population status, trends, habitat conditions, and relative level of stressors. If regularly updated and maintained, managers would be able to set quantitative management objectives for each species and evaluate how well they were meeting their objectives over time. This information could be summarized in a public website, thus communicating the status of these species to the general public.
- Conduct more training in field identification and survey methods. Training is often the limiting factor in many natural history surveys.
- Increase efforts to involve the public, K-12 schools, and colleges in collecting inventory and monitoring data on a wide range of species. A large organizational and planning effort on the part of the WDNR would need to precede such involvement. The federal government and universities could provide needed biological and statistical expertise to increase the overall quality of any new programs that are planned.

5.5.4 Mammals

WDNR and public volunteers currently collect the vast majority of mammal monitoring data in Wisconsin, most of which are focused on game animals and a few Threatened or Endangered species (Appendix D, Table 4). Even within the game category, however, inventory and monitoring efforts are considered adequate only for quota harvested species, a relatively small group where harvests are restricted through permit systems (Wisconsin DNR 2004c). Existing surveys gather a small amount of information on some Species of Greatest Conservation Need (Appendix D, Table 4), but they do not cover all topics or types of data needed to implement a comprehensive conservation plan. Existing programs must be expanded and new programs must be carefully designed to address the significant weaknesses noted in the Inventory and Monitoring Review (Wisconsin DNR 2004c). Table 3-1 in Chapter 3 provides a complete list of mammal Species of Greatest Conservation Need. This list also notes the species for which we need more data regarding state abundance, threats, population trend, or global threats.

Gaps in Mammalian Monitoring

Insectivores and Small Rodents

Based on the 2004 review, inventory and monitoring efforts are not adequate to address *any* topic area for this group, including population trends, distribution and range, habitat requirements, habitat condition and availability, population status, and wildlife health. Inventory and monitoring efforts should be increased to address these deficits.

Large Rodents, Rabbits, and Hares

Inventory and monitoring efforts are, in general, adequate to address distribution, habitat condition, and habitat availability for this group; however, we have little or no information on these topics for Species of Greatest Conservation Need. Current efforts are deemed inadequate to address population trends, population status, and wildlife health for the species in this group. Inventory and monitoring efforts should be increased, especially with respect to Species of Greatest Conservation Need.

Bats

Inventory and monitoring efforts for bats are not adequate to address *any* topic area, including population trends, distribution and range, habitat requirements, habitat condition and availability, population status, and wildlife health. Inventory and monitoring efforts should be increased to address these deficits.

Weasel Family, Raccoon, and Virginia Opossum

Inventory and monitoring efforts are adequate to address distribution, habitat condition, and habitat availability, and inventory and monitoring efforts should be maintained or increased. Efforts related to population trend, wildlife health, and population status should increase.

Larger Mammals

The Inventory and Monitoring Review (Wisconsin DNR 2004c) did not include moose. Inventory and monitoring efforts are adequate to address population trend, population status, distribution, habitat requirements, and habitat condition. Inventory and monitoring efforts related to those topics should be maintained or increased. Efforts are inadequate for wildlife health and current efforts should increase.

Addressing Gaps in Mammal Monitoring

Where possible, existing systems should be expanded and improved to take advantage of established infrastructure and precedence. For mammals, that might include the following:

1. *Winter Track Survey* – This survey is central to the furbearer population monitoring program and it has the ability to provide data on additional species. Routes are being expanded into central and southern Wisconsin to keep pace with expanding furbearer distributions; the pace of this expansion should be increased to accomplish statewide coverage. Required data collection on white-tailed jackrabbit should also be added.
2. *Bowhunter Wildlife Survey* – Species coverage is currently limited; consider adding several mammalian and avian Species of Greatest Conservation Need. Consider elevating the awareness of the survey through the Citizen-Based Monitoring Network and using NatureMapping as the reporting tool to improve spatial data collection and timeliness.
3. *Summer Wildlife Survey* – Add recognizable Species of Greatest Conservation Need (e.g., Franklin's ground squirrel and white-tailed jackrabbit).
4. *Rare Mammal Observations* – Add white-tailed jackrabbit and Franklin's ground squirrel. Increase awareness of what constitutes a rare mammal sighting and reporting rates. Consider using NatureMapping as a reporting tool.
5. *Small Mammal Inventory* – Increase the overall effort. Publish existing protocols, standards, and methods. Expand partnership development and increase support, especially through graduate programs and the Citizen-Based Monitoring Network of Wisconsin.
6. *NatureMapping* – Significantly expand the public and professional awareness and use of this program. Add "Special Projects" to assist with standard DNR wildlife surveys such as the Bowhunter Wildlife Survey, Summer Wildlife Survey, Rare Mammal Observations, and Small Mammal Inventory.

Where there is no precedent and infrastructure do not exist, we recommend careful consideration of the following points:

1. *Bats* - The North American Bat Conservation Partnership (NABCP) outlines a strategic plan (<http://www.batcon.org/nabcp/newsite/index.html>) for identifying and addressing priorities related to research, monitoring, and management actions. The plan provides the framework and direction for local, state, and federal bat conservation and management plans. The DNR and partners should develop a state plan following the NABCP guidelines, goals, and priority actions.
2. *Quantitative Review of Existing Surveys* - Conduct a detailed evaluation of mammalian surveys, determine long-term monitoring priorities, and develop a Coordinated Wildlife and Habitat Monitoring Plan in conjunction with other taxa groups.

5.5.5 Terrestrial Invertebrates

Current monitoring efforts are taxa-specific due to the particular expertise of individual scientists. Several subgroups remain unevaluated because of the high species diversity of terrestrial invertebrates and limited taxonomic expertise among biologists in the state of Wisconsin. See Appendix D, Table 5 for details on monitoring surveys for terrestrial invertebrate Species of Greatest Conservation Need. Monitoring is adequate only for the following subgroups and topic areas:

- Hemipteroid Orders - habitat requirements
- Orthopteroid Orders - population status and trends and habitat requirements
- Panorpoid Orders - population status and trends; habitat requirements, conditions, and availability

Several hundred terrestrial invertebrate species are listed as Species of Greatest Conservation Need in Wisconsin (Tables 4-1, 4-2, and 4-3). See Chapter 4.0 for more details on invertebrate Species of Greatest Conservation Need threats and priority conservation actions.

Gaps in Terrestrial Invertebrate Monitoring

Monitoring is insufficient for all topic areas (population status and trends; distribution and range; wildlife health; habitat requirements, conditions, and availability) for most terrestrial invertebrate Species of Greatest Conservation Need. Work should increase or be undertaken soon to address these gaps (Wisconsin DNR 2004c). Additional inventory and monitoring work is needed on endemic and threatened habitats, using a wider variety of sampling methods. An assessment is also needed of potential interactions among native Lepidoptera and introduced European moths in habitats where they coexist (Wisconsin DNR 2004c).

Addressing Gaps in Terrestrial Invertebrate Monitoring

A comprehensive plan for achieving monitoring goals is not in place for terrestrial invertebrates. The taxa group needs to be included in coordinated fish and wildlife monitoring plans. The DNR has the knowledgeable staff, infrastructure, and statewide perspective to work with certain terrestrial invertebrate groups, but expertise for other taxa is lacking (Wisconsin DNR 2004c). Funding to support terrestrial invertebrate monitoring is low overall, although select taxa are being addressed (e.g., Karner blue butterfly). Citizen scientists could help provide data on the distributions and habitats of select taxa that are relatively common and easily identified, if provided with photos, reference specimens, and user-friendly taxonomic keys. Additional recommendations and conservation actions can be found in the invertebrate section of this report (Chapter 4).

5.5.6 Aquatic Invertebrates

Current monitoring efforts are taxa-specific due to the particular expertise of individual scientists. Several subgroups remain unevaluated because of the high species diversity of aquatic invertebrates and limited numbers of experts in the state of Wisconsin. See Appendix D, Table 6 for details on monitoring

surveys for aquatic invertebrate Species of Greatest Conservation Need. Monitoring is adequate for the following groups and topic areas:

- Introduced and Accidental - population status
- Crustacea - population status and trends; distribution and range; habitat requirements, conditions, and availability
- Mayflies - population status
- Dragonflies and Damselflies - population status and trends; distribution and range; habitat requirements, conditions, and availability
- Alderflies and Fishflies - population status and trends; distribution and range; habitat requirements, conditions, and availability
- Aquatic Bugs (Heteroptera) - population status and trends; distribution and range; habitat requirements, conditions, and availability
- Aquatic Moths and Spongillaflies - habitat requirements, conditions, and availability
- Aquatic Beetles - population status and trends; distribution and range; habitat conditions, and availability
- Snails, Limpets, Clams, and Mussels - habitat requirements, conditions, and availability

Several hundred aquatic invertebrate species are listed as Species of Greatest Conservation Need in Wisconsin (Tables 4-1, 4-2, and 4-3). See Chapter 4.0 for more details on invertebrate Species of Greatest Conservation Need threats and priority conservation actions.

Gaps in Aquatic Invertebrate Monitoring

Current monitoring efforts are inadequate for several aquatic invertebrate subgroups and topic areas. Work should increase or be undertaken soon to address these gaps (Wisconsin DNR 2004c). Monitoring is insufficient for all topic areas (population status and trends; distribution and range; wildlife health; habitat requirements, conditions, and availability) for the following aquatic invertebrate groups:

- Endangered, Threatened, and Special Concern species
- Aquatic worms and leeches
- Stoneflies
- Caddisflies
- Aquatic flies and midges

Addressing Gaps in Aquatic Invertebrate Monitoring

A comprehensive plan for achieving monitoring priorities is not in place for aquatic invertebrates. The taxa group needs to be included in coordinated fish and wildlife monitoring plans. The DNR has the knowledgeable staff, infrastructure, and statewide perspective to work with certain aquatic invertebrate groups, but expertise for other taxa is lacking (Wisconsin DNR 2004c). Funding to support aquatic invertebrate monitoring is low overall, although select taxa are being addressed (e.g., odonates). With proper training, citizen scientists could help provide fundamental data on the distributions and habitats of select taxa that are larger in size and easily identified (e.g., lepidopterans; odonates; crayfish; and some mussels, snails, and heteropterans).

Recommendations for additional aquatic invertebrate inventory and monitoring work include the following:

- Developing rearing programs to establish larval/adult associations, especially for Natural Heritage Inventory Working List species.

- Provide funding to publish surveys of discrete groups for which data already exist.
- Update and expand the Hilsenhoff Biotic Index.
- Expand survey work to include State Parks and State Natural Areas.
- Conduct invertebrate surveys of the Pine-Popple River System and the upper Wisconsin River System to compare the fauna of impacted and pristine river systems (Wisconsin DNR 2004c).

Additional recommendations and conservation actions can be found in the invertebrate section of this report (Chapter 4).

5.6 Species of Greatest Conservation Need Habitat (Natural Community) Monitoring

Many resource management organizations, including WDNR, have attempted to shift from species to ecosystem-based management strategies (Pikitch 2004) which focus on habitats and multi-species, trophic interactions (National Research Council 1999). The *Wisconsin's Biodiversity as a Management Issue* report (Addis et al. 1995) recommended the development and use of statewide resource inventories within the ecoregions of Wisconsin (including assessments of the status and distribution of aquatic and terrestrial species, biological communities, and other attributes). This increased the need for broad scale vegetation, natural community, and landscape data collection and the creation of the Aquatic and Terrestrial Resources Inventory to function as a statewide information center that could facilitate the maximum use of those data.

In 2004, WDNR reviewed bird, mammal, herptile, invertebrate, and plant inventory and monitoring programs to assess the adequacy of our resource programs and information (Wisconsin DNR 2004c). The review was conducted by asking taxa experts, most of whom were consumers of natural resource inventory and monitoring data, to provide feedback on data gaps, priorities, and niche related questions. The review, and subsequent assessments conducted for this Comprehensive Wildlife Conservation Plan, identified numerous species or taxa-specific surveys, but few natural community or ecoregional monitoring programs. A listing and description of the existing or historic aquatic and terrestrial community monitoring programs can be found in Appendix D, Tables 7 and 8.

Monitoring activities are generally designed to measure the composition, structure, or function of an ecosystem. Composition, or the plants, animals, and habitat types that occupy an area, can be defined at different scales, from ecosystems within a landscape to the genetic composition of species. Structure refers to the physical organization and distribution patterns of plants and animals. Monitoring for structure usually indicates floristic and faunal guild diversity. Function refers to the interactions of biotic and abiotic components in ecological processes. Most monitoring efforts in Wisconsin focus on species and habitat composition, leaving gaps in our knowledge of ecosystem structure and function. At a coarse landscape-level, there are monitoring efforts that focus on the placement and condition of natural communities, and trends that affect them such as housing development and global climate change. Most of these efforts are conducted by the federal agencies at the regional or national level.

A number of long-term capital improvement-type projects are required to facilitate habitat and ecosystem monitoring in Wisconsin. First, we need to create an updated landcover GIS layer; the current version, called "WISCLAND," is based on images from 1992-93. Significant changes in land-use have occurred across many ecosystems since that time, the consequences of which are not readily known. A second need is the creation of a statewide registry of conservation practices. Currently, these data are only available in a spatial (i.e., GIS) format for specific project areas. The entire discipline of landscape ecology is based on understanding the spatial relationships (i.e., patch size, shape, position) of habitats at appropriate scales. Knowing where and, to some extent, when conservation practices were implemented on private lands will assist resource managers in assessing everything from the viability of nesting habitat for the greater prairie chicken to non-point pollution loading in streams, rivers, and lakes.

5.6.1 Overview of Habitat Monitoring Gaps

The Inventory and Monitoring Review (Wisconsin DNR 2004c) covered the adequacy of current inventory and monitoring efforts for natural communities, but did not directly address ecoregional issues. Most reviewers indicated that current efforts were not adequate to address data and information needs for natural communities and that work should increase. Particular deficiencies included a lack of standardization, coordination, monitoring of forest management for effectiveness and impacts, and staff to track field information and manage databases. They recommended the development of a statewide

inventory and monitoring network to monitor natural communities, with a special emphasis on invasive plants. The WDNR and Wisconsin Herbarium have an early detection program for new invasive species and other agencies collect data about invasive species occurrence and control efforts; however, a broadly accessible database is needed to coordinate and track habitat monitoring and management programs.

Sections 5.6.2 through 5.6.8 provide a description of the specific monitoring gaps that have been identified for each of the natural community groups evaluated during the development of Wisconsin's CWCP.

5.6.2 Gaps in Aquatic Monitoring

Aquatic monitoring programs have been in place since the late 1930s, covering many streams and rivers, Lakes Michigan and Superior, several hundred inland lakes, and the watersheds contributing to these aquatic systems. Many programs evaluate heavily-used waterbodies (e.g., Lake Winnebago) but detailed surveys of small, isolated streams have also been conducted. Current surveys range from detecting changes in water quality using satellite data to investigating the impacts of commercial development and non-indigenous species (Appendix D, Table 7). Aquatic monitoring may also contribute to the designation of State Natural Areas or Outstanding and Exceptional Resource Waters (OERWs).

High-priority needs, or gaps, listed in the recent *Water Resources Monitoring Strategy for Wisconsin* (Wisconsin DNR 2005) included the following:

- Developing a Lake Index of Biotic Integrity (IBI) incorporating baseline monitoring data
- Funding and staffing to cover all high-priority river reaches statewide
- Additional funding for ongoing Mississippi River water quality monitoring
- Gathering land use data and combining land use data with baseline monitoring to enhance the predictive capabilities of the WDNR non-point source program
- Restoring recently closed stream flow stations to evaluate effectiveness of the infiltration performance standard
- Spatiotemporal expansion of water toxicity testing for biological effects; make toxicity data more accessible to WDNR staff and external customers
- Developing a coordinated, online database for all water-related data; implementation of the Surface Water Integrated Monitoring System (SWIMS) is underway

If more funding becomes available, additional monitoring priorities include the following:

- Increasing efforts toward a formal stream classification monitoring system
- Expanding surface water quality monitoring to include 1st and 2nd order streams
- Chemical analyses of waters receiving effluents from permitted entities
- Total Maximum Daily Load (TMDL) source monitoring
- Increasing TMDL 303(d) listing efforts
- Contaminated sediments monitoring
- Inland beach pathogen monitoring
- Volunteer beach pathogen monitoring of Great Lakes hotspots
- Groundwater data mining, database development and management; production of groundwater maps and other educational materials
- Establishing a statewide volunteer coordinator

5.6.3 Gaps in Barrens Monitoring

Though both large and small-scale efforts at inventory and monitoring of barrens exist, the data aren't always widely available. For example, students from Northland College in Ashland, Wisconsin, conduct biannual monitoring on Moquah Barrens in northern Wisconsin. The results are shared with Chequamegon-Nicolet National Forest staff, but are not readily available to other barrens managers. The lack of a statewide clearinghouse for these types of data limits their use by other researchers and land managers.

Access to a statewide invasive species database for barrens managers will help with effective invasive plant management. Data currently being collected on insect and disease threats to oaks are used in ecosystem management (Appendix D, Table 8). Other gaps in monitoring and inventory of barrens habitats include the need to describe the full range of variability of these communities (Addis et al. 1995).

Intense recreational use, especially motorized recreation, can cause degradation of communities through soil erosion and compaction, distribution of non-native species, and fragmentation. Currently there are no widespread, standardized monitoring programs to determine the effects of recreation on our natural communities.

5.6.4 Gaps in Grassland Monitoring

Access to a statewide invasive species database for grassland managers will help with effective invasive plant management. There is also a lack of comprehensive monitoring of the effects of management on the native diversity of grasslands. Some of the less common types of grasslands require more extensive floristic studies to capture the full range of community variability.

Intense recreational use, especially motorized recreation, can cause degradation of communities through soil erosion and compaction, distribution of non-native species, and fragmentation. Currently there are no widespread, standardized monitoring programs to determine the effects of recreation on our natural communities.

5.6.5 Gaps in Northern Forest Monitoring

Access to a statewide invasive species database for northern forest managers will help with effective invasive plant management. Data currently being collected on insect and disease threats to oaks are used in ecosystem management (Appendix D, Table 8).

Deer herbivory is a common threat to components of many northern forest communities, but there is no consistent monitoring of herbivory to determine how widespread or long-lasting the effects might be. There is also a need for a consistent monitoring program of the effects of forest management and recreation on forest structure, composition, and function (Wisconsin DNR 2004c).

Human-created transportation corridors contribute to changes at large and small scales, including fragmentation, movement of invasive species, and changes in hydrologic regimes. An inventory of roads, trails and other transportation corridors, both official and user developed, would allow land managers to determine the effects of those corridors. Data on habitat losses due to fragmentation and rural development are being collected but are not widely disseminated for use by land managers (Appendix D, Table 8). Intense recreational use, especially motorized recreation, can cause degradation of communities through soil erosion and compaction, distribution of non-native species, and fragmentation. Currently there are no widespread, standardized monitoring programs to determine the effects of recreation on our natural communities.

Monitoring as part of an adaptive management program is needed to support an increase in the range of age classes and community components of some of the northern forest communities. Other northern forest communities need both more inventorying (to identify intact, high-quality sites and to determine the status of associated rare species) and more monitoring (to determine composition, function, and processes).

5.6.6 Gaps in Oak Savanna Monitoring

According to the Midwest Oak Ecosystems Recovery Plan (U.S. EPA 1994) there are presently numerous public and private agencies, organizations, and institutions that are conducting research and prescribing and implementing management to restore savanna and woodland natural communities in the Midwest. Often managers and researchers are not aware that databases of ongoing or recently completed research exist. One important challenge is to bring the vast amount of information contained in these databases together in a format that is accessible. Some of the gaps in information include 1) classification and characterization of savannas and woodlands, 2) threats to the ecosystem, and 3) inventories of what is protected (U.S. EPA 1994).

One threat to oak savannas is invasion by non-native plant species, and access to a statewide invasive plant species database for savanna managers will help with effective invasive plant management. Data currently being collected on insect and disease threats to oaks are used in ecosystem management (Appendix D, Table 8).

Some savanna communities need more inventorying to identify potentially restorable sites. Monitoring of oak regeneration would facilitate management to enhance regeneration success. Data on habitat losses due to fragmentation and rural development are being collected but are not widely disseminated for use by land managers (Appendix D, Table 8). Intense recreational use, especially motorized recreation, can cause degradation of communities through soil erosion and compaction, distribution of non-native species, and fragmentation. Currently there are no widespread, standardized monitoring programs to determine the effects of recreation on our natural communities.

5.6.7 Gaps in Southern Forest Monitoring

To use adaptive management techniques to manage southern forests as a matrix of community types, we need to bring together the large amount of existing technical information on silviculture, forest ecology, and wildlife ecology by establishing a natural community information system (Addis et al. 1995). Monitoring as part of that program is needed to support the restoration of structure, function and composition in some southern forest communities. In addition, a platform needs to be created to share that information with other southern forest managers. Some southern forest communities still need more inventorying to identify intact, high-quality sites and degraded but restorable sites, and to determine the status of rare species. More inventory work is also needed to document the variability of southern mesic forest communities. Monitoring of oak regeneration would facilitate management to enhance regeneration success.

Access to a statewide invasive species database for southern forest managers will help with effective invasive plant management. Data currently being collected on insect and disease threats to oaks are used in ecosystem management (Appendix D, Table 8). New monitoring efforts for the emerald ash borer will likewise be used.

Deer herbivory is a common threat to components of many southern forest communities, but there is no consistent monitoring of herbivory to determine how wide-spread or long-lasting the effects might be.

Human-created transportation corridors contribute to changes at large and small scales, including fragmentation, movement of invasive species, and changes in hydrologic regimes. An inventory of roads, trails and other transportation corridors, both official and user developed, would allow land managers to determine the effects of those corridors. There is also a need for a consistent monitoring program of the effects of forest management and recreation on forest structure, composition, and function (Wisconsin DNR 2004c). Intense recreational use, especially motorized recreation, can cause degradation of communities through soil erosion and compaction, distribution of non-native species, and fragmentation. Currently there are no widespread, standardized monitoring programs to determine the effects of recreation on our natural communities. Data on habitat losses due to fragmentation and rural development are being collected but are not widely disseminated for use by land managers (Appendix D, Table 8).

Select taxa in hemlock relict communities need to be inventoried to determine presence and status of rare species. Also in hemlock relicts, recreational trails need to be monitored for negative effects such as invasive species and soil erosion.

5.6.8 Gaps in Wetland Monitoring

A statewide inventory and monitoring system for invasive plants is needed (Wisconsin DNR 2004c). The current reed canary-grass mapping project is a start towards a statewide inventory, with an expected completion date of 2006 (Appendix D, Table 7). The purple loosestrife survey and mapping projects are conducted on a volunteer basis so there may be gaps and inconsistencies in the quality and quantity of the data.

The methods for the Wisconsin Floristic Quality Assessment for Wetlands (Appendix D, Table 7) have been developed, and software for sharing the methods is to be released in the near future. However, development of a database for the results and making that database widely available are dependent on future funding (Tom Bernthal, personal communication, 2005).

Other recommendations for inventory and monitoring wetlands listed in *Wisconsin's Biodiversity as a Management Issue* (Addis et al. 1995) and the *Water Resources Monitoring Strategy for Wisconsin* (Wisconsin DNR 2005) include the following:

- Utilize the Natural Heritage Inventory to identify high-quality, undisturbed wetlands that should be protected.
- The WDNR wetland inventory maps should be updated every ten years for effective monitoring for state wetland protection and regulatory needs. In addition, the information needs to be collected and disseminated in an easily accessible manner. This will require additional staff and funding.
- The inventory mapping program should continue to be integrated with the Department's overall Geographic Information System program and the Department's Aquatic and Terrestrial Resources Inventory.
- Reliable funding is needed to implement a wetland assessment and monitoring program.

5.7 Importance of Citizen-collected Data to CWCP Monitoring

Citizen-based monitoring can and will greatly augment our ability to fill the gaps identified for monitoring Species of Greatest Conservation Need and their habitats. Recognizing that, it is important to understand the potential roles of citizen-based monitoring and the components of a successful citizen-based monitoring program.

In 1998, private citizens acting as volunteers through nonprofit organizations in the United States provided work equivalent to 9.3 million fulltime jobs (Independent Sector, 2001). As the baby boom generation enters retirement, the number of volunteers interested in the assessment and protection of natural resources will only increase.

Wisconsin in particular has a history of long-term, successful citizen-based monitoring programs. A wide array of organizations and agencies have developed longstanding or expanding efforts such as volunteer lake and stream monitoring programs, the Wisconsin Frog and Toad survey, Naturemapping, the Breeding Bird Survey, Christmas Bird Counts, and the Statewide Small Mammal Inventory. Indeed, these sources were relied on heavily in the assessment of Species of Greatest Conservation Need and critical habitats for this plan.

As part of the WDNR Inventory and Monitoring Review (Wisconsin DNR 2004c), citizen-based programs were seen as critical in addressing problems of shrinking state resources, both in terms of staffing and project funding, while meeting the ever present and growing demands for natural resource monitoring. Consequently, natural resource experts and conservation organizations alike called for the increased use of citizen-collected data. However, there was also universal recognition that utilization of these data requires WDNR leadership in the provision of training, prioritization of effort, quality assurance/quality control, and methods development.

Properly trained citizens not only reduce the cost of data collection and ground-truthing, but they also become engaged supporters of fish and wildlife conservation. Citizen scientists can have a much more detailed and intimate knowledge of a particular landscape than agency biologists due to the amount of time that they are able to spend in that area. While citizen monitoring can provide important information at less of a cost than professionals, this is not to say that there is no cost, nor that support is not necessary.

The following citizen monitoring discussion is designed to forecast citizen monitoring opportunities and to document current activities. This section seeks to address a number of relevant questions and concerns related to citizen monitoring. The WDNR Water Monitoring Strategy specifically addresses citizen-based monitoring and relevant portions of that strategy are included in this general discussion. In the coming months, the development of a mirrored terrestrial strategy will be completed.

5.7.1 Uses of Citizen-collected Data

With the development of training, protocols, and quality assurance/quality control, citizen-collected data have the potential to contribute to the following areas as identified by the WDNR Water Monitoring Strategy and WDNR Inventory and Monitoring Review:

- Gather data concerning population trends
- Assess distribution, range, and habitat requirements
- Assess habitat conditions and availability
- Assess population status
- Establish, review, and revise water quality standards

- Identify impaired waters
- Evaluate management (protection/restoration) effectiveness
- Assess ecosystem health
- Provide broader spatial and temporal coverage in river, stream, wetland, lake, groundwater, and beach water quality
- Monitor water quality conditions to support TMDL/303(d) listing, 305(b) reports, and general information on the water quality of Wisconsin waterbodies
- Assess water quality conditions in relation to nonpoint source management projects

However, citizen monitoring opportunities may be limited for the following reasons:

- Monitoring certain resources may pose a safety hazard/unacceptable risk to citizen monitors.
- The required training level is more rigorous than is economically feasible or the cost of sample analysis prohibits widespread monitoring of the parameter.
- Equipment availability is limited or financial constraints are prohibitive.
- The size of the monitoring area prevents assessment by citizen monitors (e.g., size of area and thus time required to monitor the location would require citizen input beyond what can be expected of a volunteer).
- A high level of scientific knowledge is required to make an assessment.
- There is a lack of required support or recognition of value of collected data.
- Some rare species can be difficult to identify and proper identification must be confirmed for data to be used for conservation and regulatory purposes. Also, some habitats and species are particularly vulnerable to collection or disturbance and may not be suitable for all citizen-based monitoring efforts. Important considerations include:
 - Species identification and documentation including factors necessary to validate the observation and associated information to collect.
 - Guidelines for how and when to collect plant or animal voucher specimens including regulations and necessary permits, as well as when collection should be avoided due to laws or to protect the viability of the species' population.
 - Special considerations for minimizing impacts to high quality natural communities that are fragile or otherwise susceptible to disturbance.

Although there has been renewed interest in the expansion of citizen-based monitoring programs, a wide array of citizen activities is already underway in Wisconsin (Appendix D, Table 9). There are many options along the citizen-based monitoring data use continuum and organizations or programs may use the data differently. Some data will be used as red flags, some to replace or supplement current WDNR staff activities, and some as part of education and outreach efforts. In the coming months, the WDNR, in conjunction with external partners, will explore how to best match citizen-based monitoring activities to current priorities. Citizen monitoring will likely be an important component of monitoring programs for many Species of Greatest Conservation Need and their habitats.

5.7.2 Elements in the Development of Citizen-based Monitoring Programs

Training

Citizen groups should be provided the same level of training provided to WDNR staff for any given activity. Additional information will need to be provided to citizens in order to meet their level of experience and to orient them to agency monitoring priorities. Regardless of the specific monitoring program, all training programs should consider inclusion of the following information:

- Trespassing laws
- Liability
- Water and equipment use safety
- How to minimize the spread of exotic invasive species when monitoring
- Impacts to threatened or endangered species and their habitat
- Quality assurance and quality control measures
- General understanding of what the data mean
- Data recording, entry, reporting, and presentation
- How to geolocate monitoring locations
- Expected response from the Department to citizen-generated data results

Quality Assurance/Quality Control

Existing WDNR quality management programs, data collection standards, and metadata standards should be utilized in order for data to be accepted into agency databases. A listing of accepted non-WDNR protocols should be maintained by the WDNR and consideration should be given to the development and support of widely recognized citizen certification programs.

Methods

Citizens should be trained in standardized WDNR methodologies. Many of these methods are available in the field procedures manuals and through program websites. Challenges that need to be met for citizens to be able to follow Department methods include the following:

- Allocating staff to provide training and methods development
- Obtaining funding to purchase equipment for the citizens to use that is equivalent to equipment that the Department uses and to pay for laboratory analysis
- Training citizens to use and maintain the equipment, monitor safely, and enter and report data results
- Updating the Field Procedures Manuals
- Supporting development and enhancement of a citizen monitoring network with well-developed communication and recognition strategies defined

Evaluation

Inclusion of citizen-collected data in the implementation of Comprehensive Wildlife Conservation Plan monitoring strategies provides a unique opportunity to explore how well citizens can be trained to carry out professional-level monitoring, to address issues that are found through evaluation, and to adapt the program so that it is most efficient and useful. Areas of investigation may include the following:

- Potential new roles of citizen-based monitoring in the implementation of the Comprehensive Wildlife Conservation Plan and other initiatives
- Use of citizen-collected data in resource management decisions and the level at which programs accept such data
- Citizen-collected data as a supplement or replacement for selected WDNR-collected data
- Level of staff support needed for coordination, training and methods development
- Cost comparisons of agency and volunteer data collection

Data Management

Although citizen-collected data will reside in designated project specific databases, the greater utilization of the data for broader management and trends analysis is equally important. Adherence to accepted methods and data collection standards makes this possible. An analysis of how citizen-collected data could be utilized by the datasets discussed in the habitat monitoring section (Section 5.6) should be explored.

Support and Recognition

Citizen monitors need to be supported and recognized for their efforts through:

- Award programs
- Outreach regarding the use of citizen-collected data
- Responsiveness by the agency to needs or questions
- Training opportunities

5.7.3 WDNR Support for the Expansion of Citizen-based Monitoring Activities

Wisconsin citizen groups have demonstrated that with training and direction they are quite capable of collecting valid and accurate information and can provide cost-effective support. In recognition of these accomplishments and the need to better support natural resource monitoring efforts, the WDNR has taken the following steps:

- Creation of a statewide citizen-based monitoring network
- Creation of an advisory board to work with the WDNR on monitoring priorities, funding opportunities, legislative support, and agency responsiveness
- Establishment of a citizen-based monitoring grant program
- Creation of the Citizen-based Monitoring Network website to serve as a clearinghouse for monitoring data, training, and protocols
- Identification of data gaps and strategies for how citizens can help fill those gaps
- Review of administrative rules and department policies with regard to citizen monitoring

Citizen participation in these efforts directly benefits the community through the collection of relevant and timely community-specific data beyond the capacity of state government, and through the development of a stewardship ethic within the population. Government benefits from the expansion of citizen-based monitoring through the opportunity to initiate, augment, or replace a variety of monitoring activities now conducted by the WDNR. With appropriate guidance and follow-up, the resulting citizen-collected data may be used in the description of trends and as early indication of ecosystem or population changes.